THE PROCESS OF EDUCATION WITH AI: FROM DIGITAL TO GENERATIVE PEDAGOGY

Boris Aberšek
University of Maribor, Slovenia

For today's Net generation (especially the Alpha generation born between 2010 and 2024) and all subsequent generations, it will be imperative to redefine educational strategies in the context of rapid technological and societal change. It is necessary to consider how to proceed, as the educational challenge must be placed in a broader philosophical and cultural context, with an emphasis on the ever-rapidly evolving technology as well as the nature of knowledge and human experience. Based on the paradigm of the shift from Web 2.0 to Web 4.0 and the consequent shift from Education 4.0 to Education 5.0, potential guidelines for the development of modern education 4.0 based on digital pedagogy that combines personalized learning, real-time feedback and collaborative, interdisciplinary environments in Education 5.0 are indicated. This reflection will place particular emphasis on the role of teachers as mentors and not merely transmitters of information, as well as on the ethical, social and emotional dimensions of digital learning, and emphasize the importance of adapting educational practices to real-life contexts and future humanistic challenges of education (Flogie et al., 2025).

Digital Pedagogy and Education 4.0

Effective teaching, regardless of the modality, must always be based on pedagogy. We know from research that the learning process is influenced by a range of factors, including prior knowledge, knowledge organization, motivation to learn, competence development, intentional practice and targeted feedback, inclusive and supportive learning environments, and self-directed learning (Ambrose et al., 2010; Sharples, 2019). *Digital pedagogy* focuses primarily on how to use digital technologies to support, enable, and facilitate the learning and teaching process. The connected digital world we live in now began with the internet and the World Wide Web, but it was built on a long history of connected educational computing that goes back to the PLATO education system [1]built in the 1960s (Dear, 2017). His fundamental theories of learning were *constructivism and connectivism*, the latter emerging in the early period of Web 2.0 and highlighting the increasingly important role of technology, especially ICT in education accompanied by a learner-centered pedagogy (Aberšek, 2024a).

This doctrine continues the connectivist philosophy presented by George Siemens and Stephen Downes in two separate articles, "*Connectivism: Learning as Networking*" (Siemens, 2005a, 2005b) and "*Introduction to Connectivist Knowledge*" (Downes, 2005). Connectivism is based on the idea that we learn when we make connections between different "nodes" of information and create and maintain connections by forming knowledge. It highlights the im-

1 PLATO is a computer-aided education system created in 1960 by Donald L. Bitzer at the University of Illinois at Urbana-Champuigne (UIUC). In addition to being successfully used as a learning tool, PLATO also created one of the first successful online communities. In many ways, the development of Plat was heralded by the Internet.

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portant role that technology plays in the learning process and the ease with which technology enables students to access information in the digital age. Connectivism is therefore student-centered, as it transfers learning responsibilities from teacher to student so that the learner understands the information they discover in the digital world. This interaction with the digital world means that connectivism also treats learning as a social process, not just as something that is exclusively internal and individual, but something distributed and dynamic. She suggests that by learning to navigate a network of resources and developing networks of resources, students take responsibility for their intellectual development with their peers. This includes the development of critical digital skills, including digital literacy, network literacy and critical assessment of information coming from different and often conflicting sources. In this context, the role of the teacher becomes primarily the creation and formation of learning communities and the creation of stimulating learning environments (Aberšek, 2024b). Connectivity has therefore laid the foundations for approaches that can also be called *Education 4.0* and laid the seeds for education enabled by artificial intelligence, *Education 5.0*. In 1966, Patrick Suppes, a pioneer of computer learning, envisioned a future in which students would have access to vast amounts of knowledge with the help of computer mentors. He predicted that millions of schoolchildren would have access to what Philip of Macedon's son Alexander enjoyed as a royal right: the personal services of a teacher as well-informed and responsive as Aristotle (Suppes, 1966). When, how, and whether this will be possible in the near future for the entire population is the next fundamental question that the profession will try to find an answer to in the coming years.

Generativism and Education 5.0

Today, it is increasingly clear that the future of education will also be defined by cooperation with generative artificial intelligence (GUI) in all fields, and that there will need to be intensive cooperation between both types of intelligence, human and artificial, to create some new social order, including education (Pratschke, 2024). The GUI is ready to change practice in all areas. As practice changes and GUI becomes part of the research and discovery process in education, it will also transform our society with education at the forefront. But what does this mean in practice? How can we work with GUIs to design learning? *Generativism describes a symbiotic approach to designing and delivering learning in collaboration with GUIs***.** It is based on *the principle of learning as a process* and on some of the most important and influential learning theories and approaches of our time:

- *constructivism*, which emphasizes the need for active learning to construct meaning; connectivism, which emphasizes the role of the digital network, in which students are active actors in this learning;
- *social learning*, which emphasizes the importance of community and cooperation;
- *experiential learning*, which emphasizes the role of learning by doing and reflecting on this experience, and
- *generative learning*, which presents learning as the process of creating meaning through the use of schemes.

Co-design and implementation of the learning process with the GUI is a characteristic of generativism as a practice, whereby knowledge is generated by working in collaboration with the GUI, with learning activities that are co-designed, facilitated and evaluated by the GUI. Generativism can be summarized as:

1. co-design of the learning experience in collaboration with the GUI;
2. co-implementation of learning activities and assessment in cooperation with the GUI; and
3. assessing learning as a process in collaboration with the GUI.

Generativism uses established digital frameworks as a foundation to provide the methodological approach needed to design the learning process in and for GUI-supported learning environments. This will have important implications for the dissemination of knowledge, as the way of teaching will be closely intertwined with the content, with what we teach. Teachers need to prepare students for a future in which creating, researching, and creating expertise in human-AI collaboration is extremely important. With more intelligences as sources of expertise, we are moving away from the role of the independent teacher as a carrier of content knowledge to the model of the teacher as a guide, guide and creator of creative learning environments. The design of learning must reflect this changing role of the teacher from the carrier of content knowledge to the one who promotes the process of constructing knowledge, both in people (learners) and in learning environments (AI). This role is likely to become

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more definite as we adapt education to this cooperation, as the fundamental goal of education must be to prepare learners for the world in which they will live. Students need to be able to work with the GUI, not only as a tool for effectiveness in the workplace, but as a means of exploring and creating knowledge both in their field of study and in their daily lives. With this, we may be asked a number of questions, such as:

- How can we design educational experiences that foster the critical creation of meaning that is needed when working with this emerging and still deeply flawed technology?
- How do you take advantage of the generative and social privileges of GUIs while still instilling core societal values alongside critical thinking, creativity, and exploration skills?

Generative learning

Students working with GUIs need to develop the ability to understand what and how the GUI creates and integrate this into the broader context of their knowledge, seeing the GUI as an assistant with whom they need to engage from a position of critical distance, while developing critical thinking and critical judgment (Pratschke, 2024). This learning should be human-centered, but with the help of a GUI. Digital practices combine the view of connectivism on students as agents in the digital network, with their focus on constructivism (everyone themselves must create knowledge) and active learning, where the process itself must be social and dependent on interaction with others in the network, i.e., collaborative.

Generative Transformation

Digital and generative transformation are undoubtedly changing the skill set needed to succeed in the world. The standard digital ecosystem of a physical institution (school, college) includes learning management systems (STEMs). Learning Management System (LMS), sometimes referred to as a virtual learning environment (VUO). However, it also includes all related external tools to which the institution subscribes. This network of digital tools, platforms and resources, which has been growing since the early 2000s, is at the core of the institution's digital ecosystem, offering a personal or combined offering.

Starting from the definitions of Education 4.0 and the taxonomy for teaching in the future (WEF 2023), however, this could be used as the starting point for the Education 5.0 taxonomy. In the proposed Education 5.0 taxonomy, the core levels 1 and 2 remain identical, as in Education 4.0, with a slight modification of Level 3, which covers concepts that must keep up with current technological changes and are to be understood as the skills that Education 5.0 aims to build, as shown in Figure 1.

How to proceed

We now live in a world where generative AI is all around us. This means that expertise on any topic, at any time, on any device, is always just 'one click away' away for anyone with access to the AI ecosystem. The GUI is now integrated into most of the tools, platforms, and devices we use and see when we look around. Technology continues to improve, the variety of models continues to grow, and at the same time, the integration of GUIs into other Web 4.0 tools, such as humanoid robots, continues rapidly. It is clear that the diversity of GUI models, or even in the future artificial general intelligence (USI), multimodality (working towards a world model) and integration (in software and hardware) are key topics for teachers. The GUI, Industry 4.0 or Society 5.0, has transformed the digital web of Web 2.0 tools into an ecosystem full of multiple intelligences and presence in the form of avatars, chatbots, and robots. This is a fundamental difference from the digital age (Education 4.0). Therefore, we need to approach GUI integration differently than digital technology in the past, mainly because the AI ecosystem not only improves traditional education, but allows us to create something completely new. *And whether we want it or not is no longer a question at all. The period of shock, frustration, and depression is long gone.* Learning is much more than just a workflow that needs to be made more effective. It is a journey of meaning-making and discovery, marked by moments of wonder and coincidence. It is a cognitive and affective process. Generative learning therefore depends not only on how information is presented to learners (i.e., teaching methods), but also on how learners try to make sense of it (i.e., learning *strategies* or *learning activities* to promote that meaning). This process

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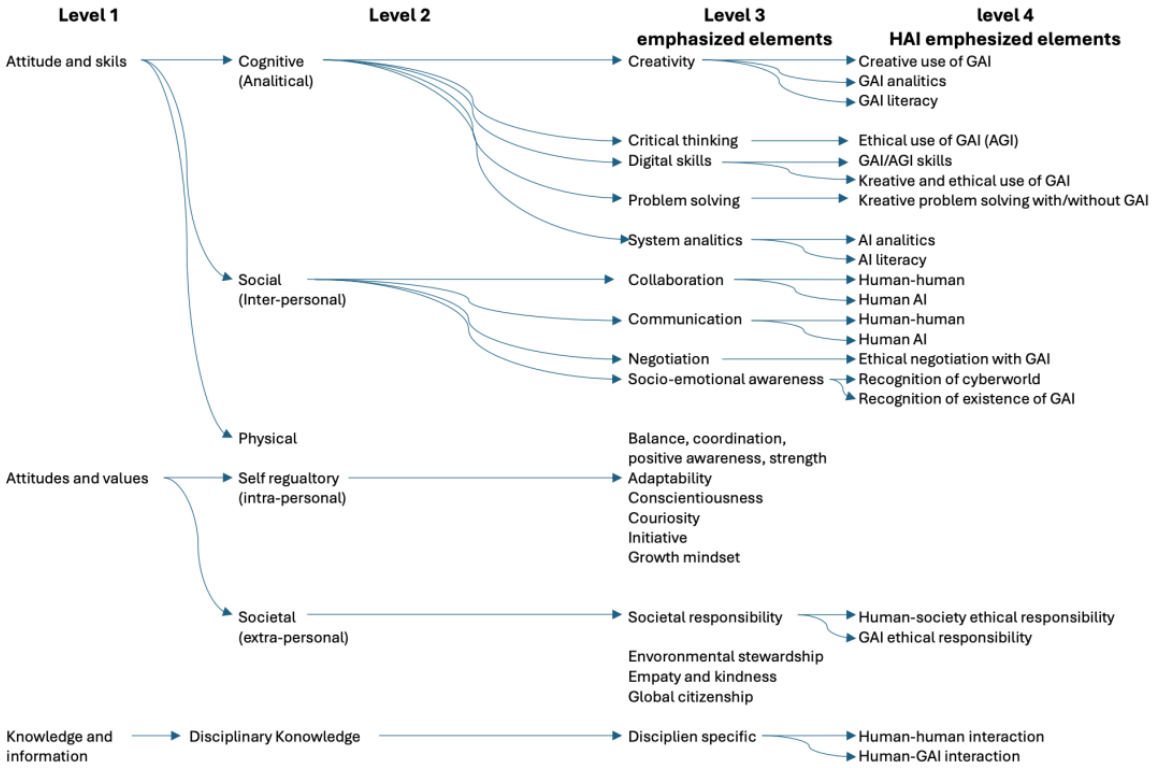
Figure 1
Education Taxonomy 5.0



is crucial: generative learning is also active learning inspired by constructivism, as it requires learners to engage with general knowledge and to integrate this knowledge into the design of their own knowledge so that they can then apply it in a different context. This knowledge-building process, which Wittrock called *meaning-making*, is fundamental when working with GUIs, as it is meant to encourage critical thinking, questioning of results, and conscious engagement with the process of making sense.

Nevertheless, the consideration of efficiency, which suggests that GUI tools can optimize the learning process, should be complemented by some concerns. Research shows that while AI assistants may be attractive, they may not aid in learning and, on the contrary, learners' competencies could regress rather than advance (Darvishi et al., 2024). In this context, it is certainly necessary to mention the cognitive *laziness*[2] that will certainly follow when AI shares space – both physical and virtual – with classmates (humans). However, once teachers acquire didactic competencies related to the use of artificial intelligence based on modern pedagogy (generativism), the disruptions in education predicted by many will be much less likely.

However, we must be aware that the implications for education will be profound.
The teacher will no longer be the sole bearer of knowledge, the written assignment as proof of what has been learned will no longer be feasible in the form we know today, and the classroom will no longer be the center of activity.

2 *Cognitive laziness* forces us to avoid looking for possible solutions (we stay on Kahneman's intuitive System 1, and don't turn on System 2, the deep, statistical way of thinking) and thus close the door to creativity. Cognitive laziness causes mild cognitive impairment, including problems with memory, language, and judgment.

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Boris Aberšek PhD, Professor, Faculty of Natural Sciences and Mathematics, University of Maribor, Koroška cesta 160, 2000 Maribor, Slovenia.
E-mail: boris.abersek@um.si
Website: https://scholar.google.com/citations?user=aRid0w4AAAAJ&hl=en
ORCID: https://orcid.org/0000-0002-4198-4240

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